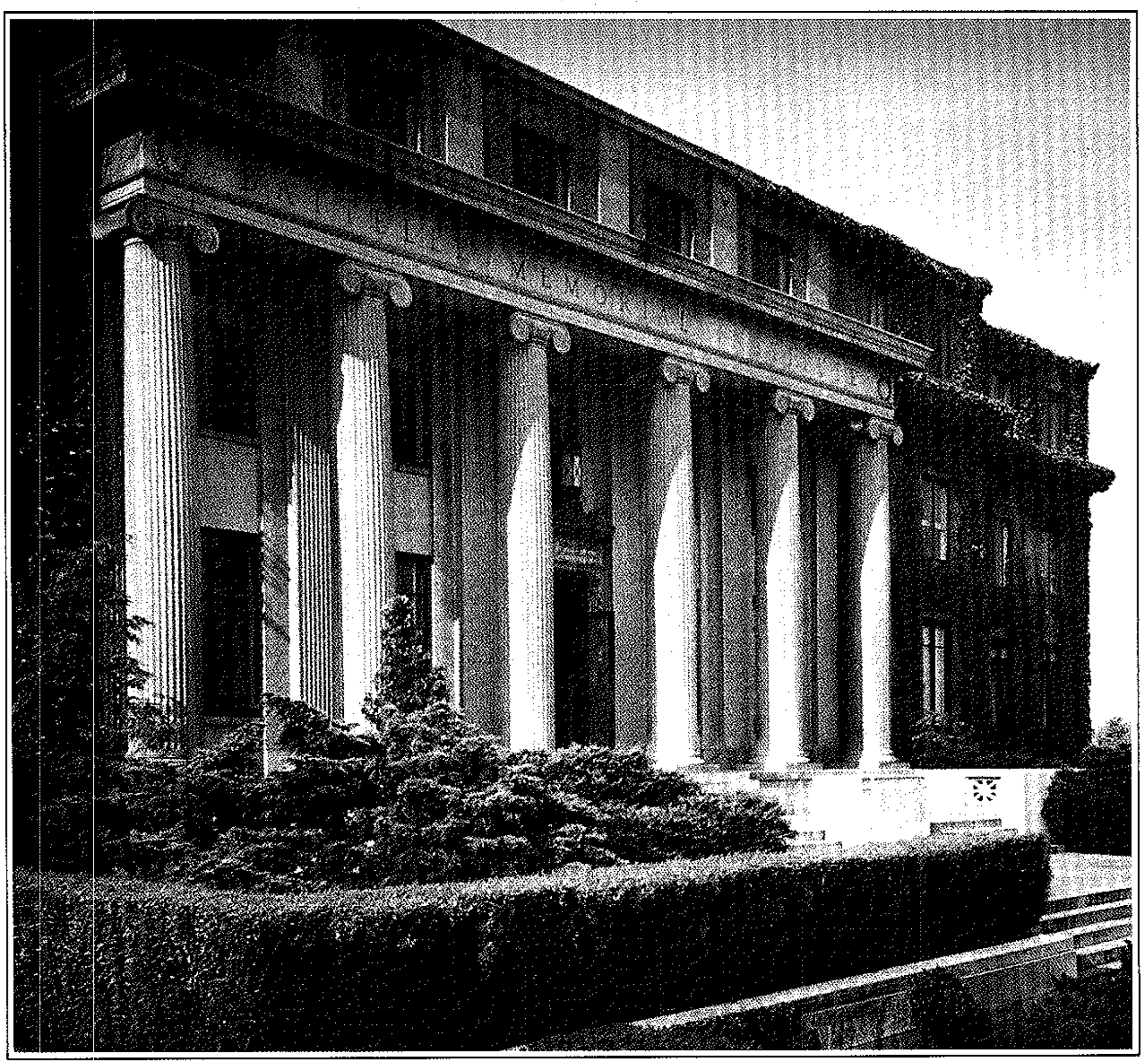
Battelle

Science Serving Human Needs

A History Of Battelle Memorial Institute



Columbus Evening Dispatch

AN INDEPENDENT NEWSPAPER.
COLUMBUS EVENING DISPATCH, DAILY.
COLUMBUS SUNDAY DISPATCH, SUNDAY
THE DISPATCH PRINTING CO.

Publication Office: Dispatch Bldg., 34 S. Third St.

Entered at the Columbus, Ohio, post office as second-class mail matter under act of congress.

MONDAY, JULY 21, 1930.

One of Our New Industries.

PERHAPS few of us appreciate the value to Columbus of the service rendered by the Battelle family in establishing the Battelle Memorial Institute, the scientific work of which was begun about a year ago, on completion of the beautiful initial building, on West King avenue.

As the end of its first year of operation approaches, its payroll, all told, has only about 50 names; but in the course of the years to come, it may mean more to the development of Columbus, even from the material point, of view, than industries which number their employes by the hundreds or thousands.

The reason why we say that it may mean more is that the Battelle Institute is working on basic problems, as yet unsolved, concerning the properties of metals and other mineral substances either already used in the arts and industries, or possibly capable of being used to advantage, after scientific research has more fully determined their properties and capabilities, either alone or in combination with other substances.

Such unsolved problems connected with mineral substancess are of untold number, and doubtless an army of scientists will be wrestling with them for generations yet to come. Sometimes such research suddenly hits upon a great discovery, utterly unforeseen, but of tremendous importance in the further development of the material and social phases of our civilization. Such discoveries are welcomed when they come, but in the usual course of things, the workers in an institution like the Battelle Memorial render their service to science and industry in a less spectacular way, constantly adding bits of new knowledge, at one point or another, which, as the years go by, effect a steady and important progress in man's task of learning the secrets of nature and turning them into instrumentalities of human welfare.

The Battelle Memorial Institute is well designed in its purpose, and so far as it has gone it is accumulating the best of equipment for the carrying out of that purpose. Its founders and directors have wisely provided ample room for the physical growth of the plant; and as its character and purpose are more fully appreciated, we have no doubt that far-seeing and public spirited men of means, in Columbus and elsewhere, will take pride in furnishing it with such additional endowment, or such special funds for the working out of particular problems in research, as may from time to time be needed.

The time will come when scientists and industrialists in many land will know of Columbus as the home of the Battelle Memorial Institute.

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Science Serving Human Needs

The history of Battelle Memorial Institute is the story of a man, of an idea, of an organization that grew out of that idea, of a dedicated staff, of some happy circumstances and some difficult problems as well, and most important, of a long line of achievements that have added human value to scientific knowledge. It is an unending story, for the Institute is both a living memorial and a dynamic multinational organization. It seems particularly timely to review this story as Battelle completes its first half century of service to society.

The man central to the story of the Institute is Gordon Battelle—a man who possessed amazing foresight and believed in the usefulness of scientific research. In death, and by his Will, he gave life to the Institute. Gordon Battelle died on September 21, 1923, leaving a Will which provided that the bulk of his estate be used to create "a Battelle Memorial Institute . . . for the encouragement of creative research . . . and the making of discoveries and inventions". The Institute was to serve as a memorial to his

Gordon Battelle (1883–1923)—the founder of Battelle Memorial Institute.

family—pioneers in Ohio and in its early steel industry.

Two years later (1925), Gordon's mother, Annie Norton Battelle, died and left the balance of the Battelle family fortune to the same purpose, making the total a sum of about $3.5 million—an impressive, although not awesome amount even by 1925 standards.

On the surface, Gordon Battelle would appear a most unlikely person to found an organization dedicated to scientific research, education, and invention and technology development activities. He was not a scientist or engineer. He was not an inventor. He didn't discover anything. He held no patents. He wrote no books. Yet his conviction that applied research had practical value has proved to be as important, as influential, and as significant a concept as any in the Twentieth Century.

Those who knew Gordon Battelle described him as quiet and serious. He was more philosopher than activist. He was a competent businessman, but not by any means a leader or innovator. He was, according to a friend, "quiet, solid and dependable".

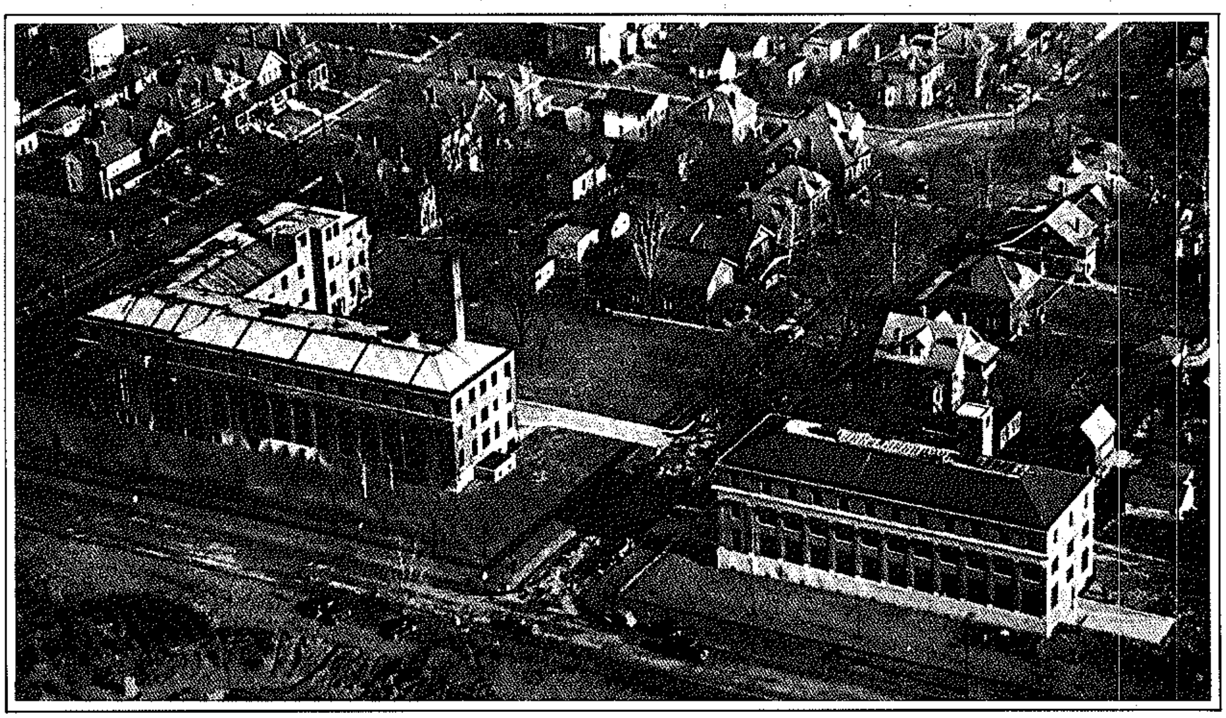
Gordon Battelle was also the son of a highly successful "self-made" man, Colonel John Gordon Battelle, who by hard work and drive came to be president of two steel companies—one of which was later to become part of the U.S. Steel Corporation and the other, a part of the American Rolling Mill Company, now Armco Steel.

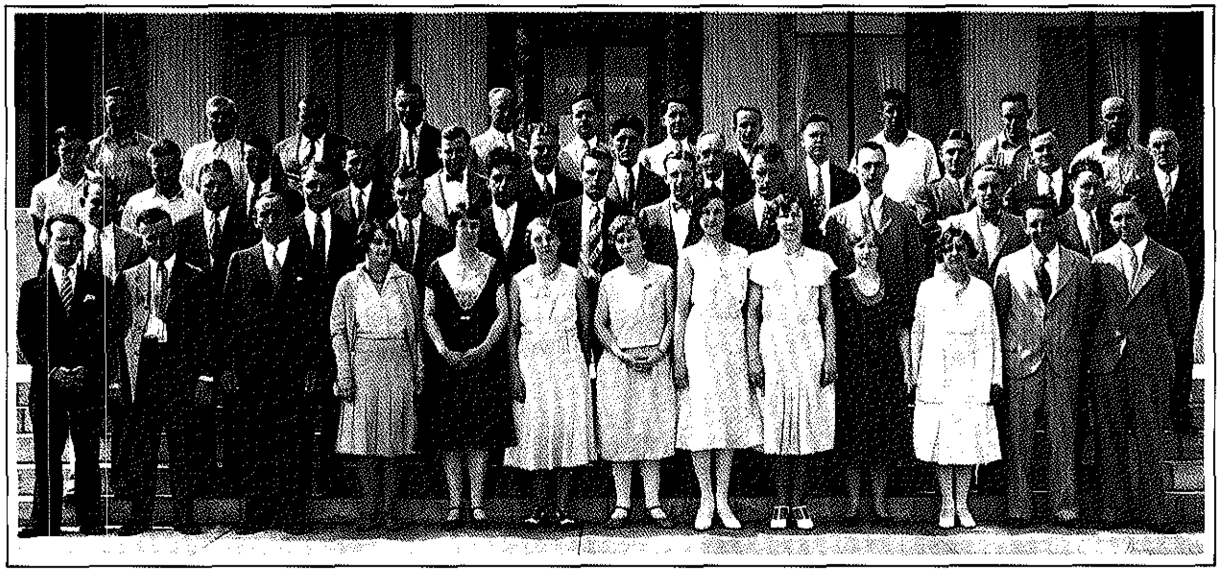
After attending Yale University, Gordon Battelle returned to Columbus to work in his father's steel mill. He began at the bottom and set about mastering every detail of the work. "But," as he told a friend, "I want to do something on my own". He did not want to be "just a rich man's son".

Following several years in the Columbus mill, Gordon went to Joplin, Missouri, where he invested in mining and smelting companies. While in Joplin, he became interested in research being done by a former university professor, W. George Waring, who was trying to develop a process for recovering valuable chemicals from waste products of mining. Gordon Battelle set up a small laboratory for Professor Waring for the research and eventually a commercial process was perfected.

Inspired by his happy experience with the research on mine wastes, Gordon Battelle began to think about the possibilities of science and of what it could do not only for industry but also for the people

Earliest known aerial view of the Institute in Columbus, taken in the 1930's, showing then-completed portions of the original building (left) and Building One, known to old-timers as "the foundry".





The Battelle staff in 1930. All but two staff members were present when this photo was taken in front of the original building.

and the society that industry serves. To learn more about research and how it was being organized, he visited many laboratories being set up by manufacturing companies.

In 1920, three years before his death, Gordon drew up his Will calling for the establishment of a Battelle Memorial Institute to be governed by a self-perpetuating Board of Trustees.

The Board of Trustees, in the four years following incorporation in 1925, acquired a site of about ten acres in Columbus on King Avenue adjacent to The Ohio State University, and carried out plans for a laboratory which was built and opened for use in October, 1929. Equally important, to begin operations, the Board chose a director—Dr. Horace W. Gillett, who was considered by his peers "The Dean of American Metallurgy".

Describing Dr. Gillett, Dr. B. D. Thomas, one of Gillett's successors at Battelle, said: "This was the man who placed the stamp of his own character on the new Battelle. This was the man who convinced the Board that scientists were trustworthy but who shocked the conservative members by insisting that scientists should have a month's vacation each year and should be required to take it. This was the man whose personality determined that the work of the Institute should initially be concerned primarily with metallurgy."

It should be noted that the Institute began operations just as the Great Depression struck—a depression that existed throughout the 30's almost to the onset of World War II. Thus, it can be said that Battelle's first 16 years—through depression and war—were far from an ideal time for a new and quite unusual organization to find its place in the world. And yet, each year in that formative period saw the Institute growing and diversifying its interests.

At the time the Institute began operations, it had a staff of about 30 people, and annual research expen-

Horace Gillett, Battelle's first Director (right), and Clyde Williams, the second Director, in the early 1930's.

The staff—about 150 people—in 1937 in front of the original building.

ditures in the first year totaled $71,000. Five years later, annual expenditures for 1935 had risen to $198,000 and the staff approached 100. And while the Institute's research activities throughout the 30's must be characterized as almost completely concerned with materials technology, including coal research, the philosophy of diversification of capabilities was constantly at work.

Significantly, Battelle's first sponsored project was the preparation of a number of volumes on metallurgy that are known collectively as The Alloys of Iron Research Monograph Series. Work on this classic series marked the beginning of Battelle's continuing and—over the years—vast contribution to technical literature.

Doubtlessly one of the most important events in the history of the Institute in the 30's was the decision by Dr. Gillett in 1934 to ask the Board of Trustees to relieve him of administrative duties and to name Clyde E. Williams as Director. To Dr. Gillett, who had a distaste for administrative duties, it was the beginning of a renewed freedom to pursue his scientific interests. To Williams, it was not so much the realization of an ambition as it was the accepting of a challenge. Faced with an industrial world that was, at best, apathetic to the potentialities of applied science, Williams resolved that if industry would not come to science, he would take science to industry.

During Williams' years as Director—the title in his later years was President—the Institute's capabilities and interests were extended far beyond materials technology to serve the changing research needs of industry, and through industry, the public. The Battelle Board and Williams recognized this need for diversification, and accordingly, the Institute acquired expertise in chemistry, physics, engineering, and economics.

One example of Battelle's efforts to broaden its capabilities was in nuclear research. The Institute became involved in the "Manhattan Project" of World War II because of its international reputation in the field of metallurgy, and was asked to study the fabrication of the then almost unknown metal uranium. In the next decade, Battelle became one of the country's outstanding centers for nuclear research, and at times, over 400 of its staff members were engaged in research in this area. Thus, in the early 50's, Battelle purchased a large tract of land at West Jefferson, just west of Columbus, and built what was the first privately owned nuclear research center in the world, including a research reactor, critical assembly facility, and hot cells.

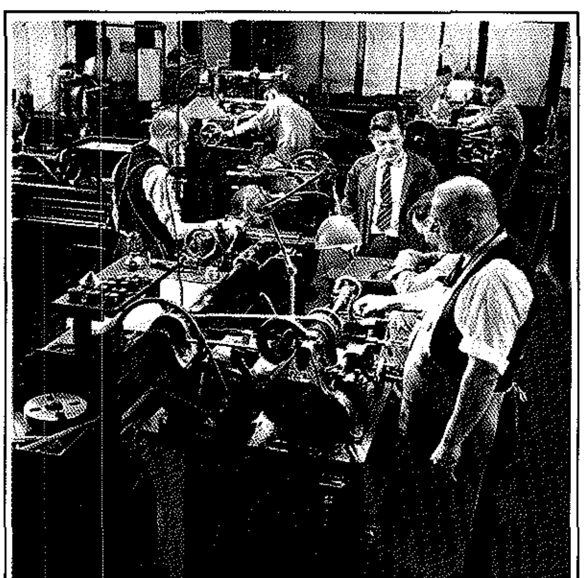
Also during this period, Battelle was by fortuitous circumstances and remarkable foresight, pursuing the development of "xerography"—a development that would later have a far-reaching effect on Battelle and on the entire business world.

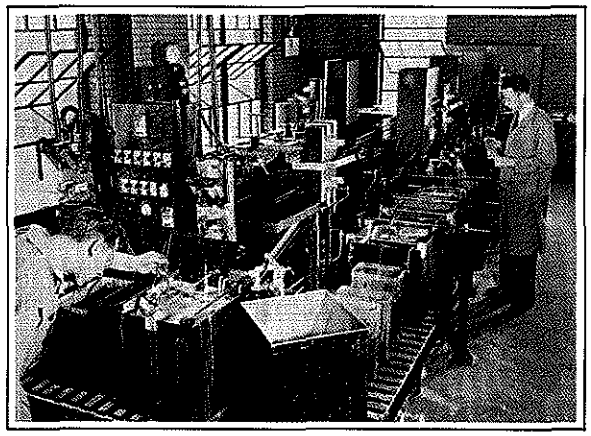
The postwar years were not only a period when Battelle expanded its range of research interests but also a period when it established its presence outside the United States. It was in the early 50's, that the Institute built research centers in Frankfurt, Germany, and Geneva, Switzerland. Establishing the Geneva Laboratories and Battelle-Institut e.V. (Frankfurt) was in itself a daring experiment, but both quickly became self-sustaining operations, bringing to Europe the concept of sponsored research.

For Battelle, the years following World War II constituted a period of amazing growth. Thus, in 1957, at the time of Williams' retirement, the total worldwide Battelle staff stood at 3100 and total annual research expenditures were just over $25 million.

Williams's retirement, and the appointment of his longtime associate, Dr. B. D. Thomas, as President, coincided closely with a rather dramatic shift in science policy in the United States and elsewhere in the world. It was in the fall of 1957 that the Soviet Union launched the first man-made satellite signaling what came to be called the Space Age or the Space Race. Battelle was actively involved in a number of facets of the space program, and emphasis on national leadership in science was reflected in the further growth and diversity of the Institute.

The machine shop, as it appeared when it was located in the basement of the original Battelle building under the library.





An early (about 1940) view of the electrochemistry laboratory where an impressive number of inventions was made.

One important factor in the growth of the Institute under Dr. Thomas's leadership was Battelle's selection by the U.S. Atomic Energy Commission to operate the former Hanford Laboratory in Richland, Washington. With the stroke of a pen, as the transfer was made in January 1965, the Institute acquired 1,959 new staff members, at what was designated Battelle's Pacific Northwest Laboratories—bringing the total staff to a new all-time high of 5,500.

Other facilities, as well, were added by Battelle during Dr. Thomas's years as President. In the fall of 1964, the Institute assumed responsibility for the management and operation of the William F. Clapp Laboratories in Duxbury, Massachusetts. Long noted as a world center for the study of marine biological attack on materials, the Clapp Laboratories complemented the Institute's Florida Marine Research Facility that Battelle had established near Daytona Beach in 1946. And, later in the 60's, Battelle was to acquire two other coastal research facilities. In 1965, the Institute purchased a 120-acre site at the mouth of Sequim Bay in the State of Washington for a marine research facility, and in early 1968 began construction of Battelle's Ocean Engineering Research Facility at Long Beach, California. The Long Beach Facility was closed in 1975 after it became apparent that the much-heralded boom in ocean-engineering research had not materialized.

There were still other facets to Battelle's building and expansion activities in the 60's. New buildings were constructed at almost all of the Institute's established research centers. And finally, there was the acquisition of an 18-acre wooded site near the University of Washington that was transformed into the Battelle Seattle Research Center—a cluster of quietly handsome buildings to house conferences and offices and provide living quarters for visiting scientists and scholars.

These years of building and expansion for Battelle reflected the mood of the Space Age and the continuing demand for its research services, but they also reflected additional financial income from the Institute's endowment, and from the commercialization of xerography.

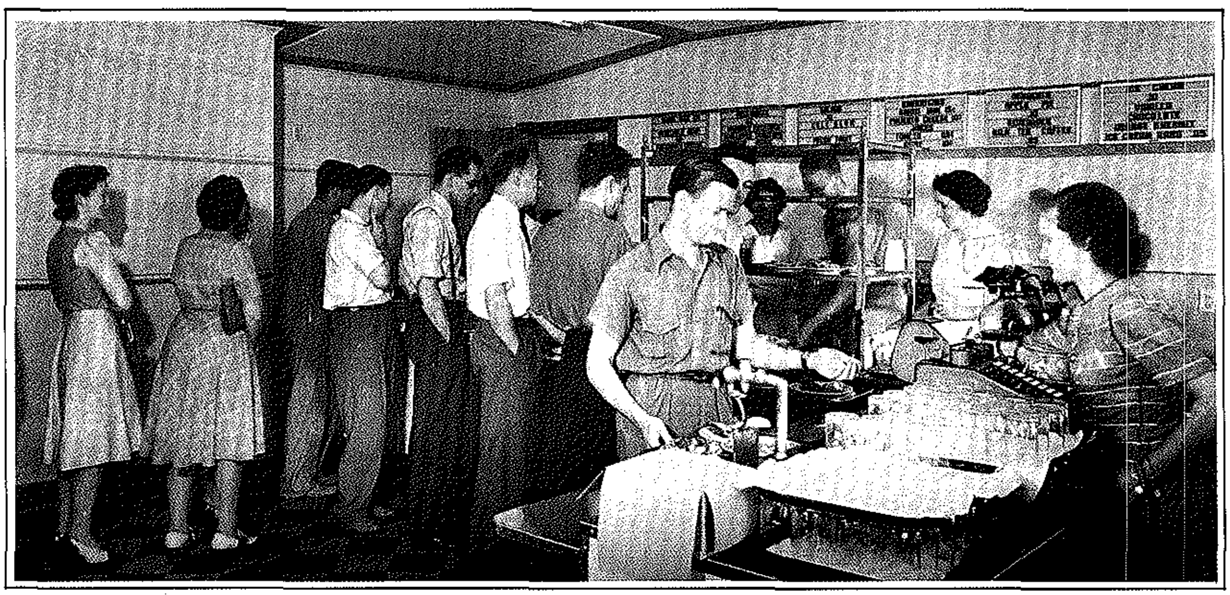
As indicated earlier, the Institute had had an important, indeed, crucial role, in making xerography a commercial reality. The Institute, through its subsidiary, Battelle Development Corporation, had by an agreement signed in 1944 set out to assist the independent inventor of xerography, Chester Carlson, in advancing the invention. Significantly, Carlson had unsuccessfully attempted to enlist the support of 20 or more companies to develop and market his invention before bringing it to Battelle's attention. For both parties, the development of xerography represented a financial drain, but one that became increasingly promising.

In December of 1946, Battelle signed the first of a series of agreements with the Haloid Company, whereby, for its continuing sponsorship of research on xerography, the Company would be given the opportunity to commercialize the process. The Haloid Company subsequently became the Xerox Corporation, and the story of its success, a legend in the business world.

In the early 60's, Battelle sold its patents on xerography to the Xerox Corporation for equity in the Corporation, and by skillful management of its Xerox stock and other holdings, added greatly to Battelle's financial assets. As a result, by the early 70's, the Institute's investment portfolio had a market value in excess of $225 million.

Thus, Battelle, which for its first 30 or more years had been forced to operate quite frugally to remain viable as a nonprofit organization, found itself in a position to greatly expand its efforts to pursue the objectives of Gordon Battelle's Will.

The Institute's Board of Trustees and officers, acting in accordance with their interpretation of the Will, elected to use the money derived from Battelle's investments to enhance its established capabilities and to reach out into new areas of research. Indeed, with Dr. Thomas's leadership,



Cafeteria on the fourth floor of the original Battelle building in 1950's, with a menu featuring roast beef for 15 cents.

Battelle's softball team in the mid-1950's—champions in Columbus' industrial league.

the Institute sought a broader approach to its mission than contract research and its traditional involvement in education. Extending its contract research efforts in the 60's into such areas as oceanography, regional planning, health care, ecology, pollution control, and urban problems was only a part of Dr. Thomas's strategy. He saw the 60's as a time when the Institute had the charter and resources to launch whole new programs to further the purposes of the Institute as stated in the founder's Will.

During this period, for example, Battelle embarked on a far-reaching program, known as the Battelle Institute Program, through which it sought to make significant contributions to human knowledge and to the professional development of researchers. The Program, funded by Battelle, provided support for a cadre of Fellows appointed from sources outside Battelle as well as from existing Battelle staff to conduct work of a basic or scholarly character. This program, which began in 1966 with an annual budget of about $1.5 million, grew to be a $5 million a year program in the early 1970's.

Following along later was another major program conceived in the same spirit in which Battelle used its own resources for the public good—the Battelle Energy Program. This program, championed by Dr. Sherwood L. Fawcett, Dr. Thomas's successor, was a multimillion dollar effort to provide research leadership in dealing with the energy crisis. Significantly this program was begun in 1973 in advance of the OPEC embargo.

Ultimately, in 1974, the Institute's multifaceted research and education effort, carried out at its own expense, accounted for annual expenditures of some $10 million.

But what had started out to be the happiest of problems—wealth—became a very painful problem and the basis of protracted litigation.

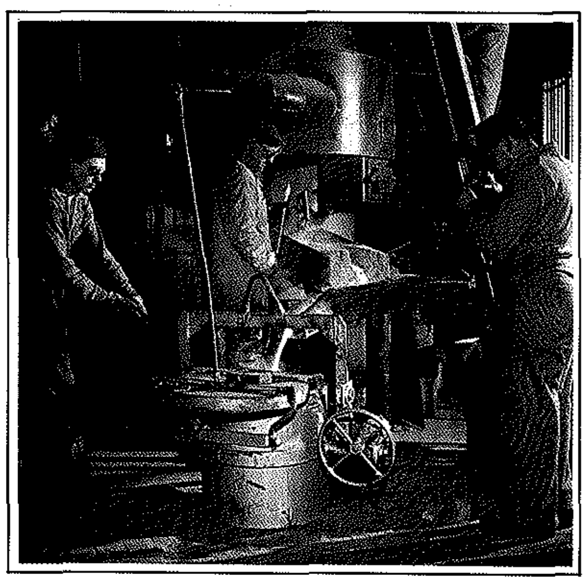
The legal action began in March 1969 and grew to several cases. The central case, brought by the Ohio Attorney General in the Franklin County Court of Common Pleas, primarily undertook to interpret the founder's intent with respect to the scope of the Institute's activities and the distribution of funds to other charitable institutions.

The cases were not closed until May 1975, with a court decision that included a detailed interpretation of the Will of Gordon Battelle defining the scope of the Institute's activities. Part of the decision was a requirement to distribute $80 million to other charitable endeavors.

From 1961 on, the Institute had also been involved in negotiations with the U.S. Internal Revenue Service concerning the taxability of various Battelle activities. As a result of these negotiations, Battelle agreed to pay $47 million in Federal taxes and to become a Federal Income tax-paying organization in the future.

These two settlements taken together represented a total of $127 million and required the divestiture of most of Battelle's investment portfolio and necessitated a quick and drastic reduction in Battelle's research and development and educational programs.

Hot and sweaty research about 1940—melting iron in the foundry area in Columbus.



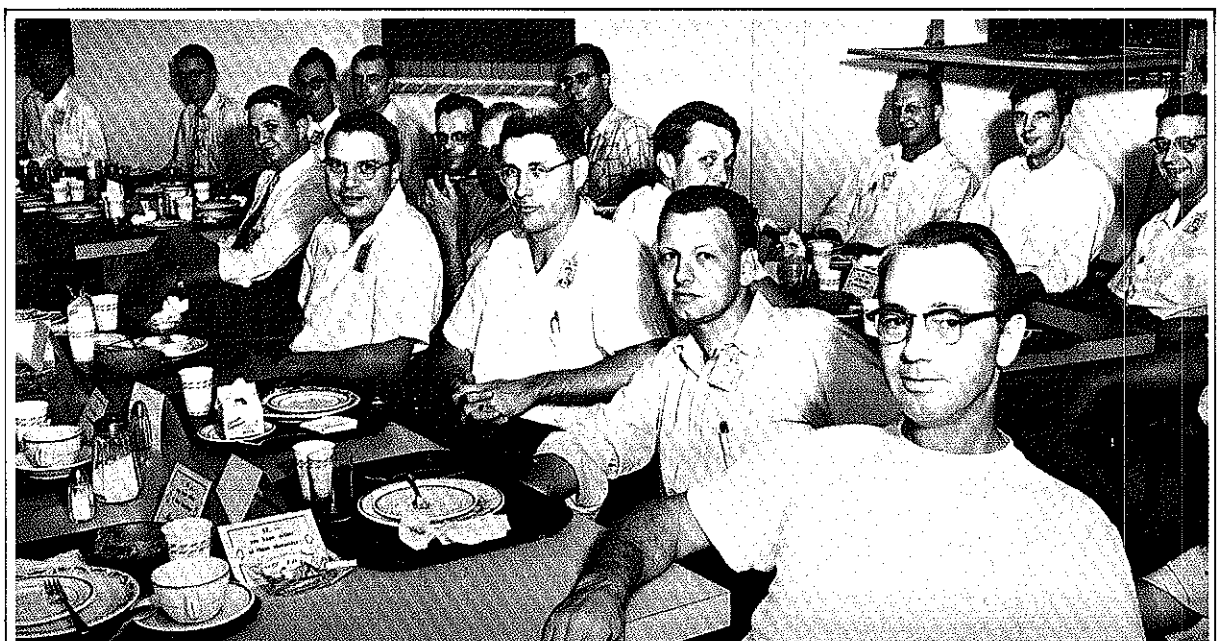
For Sherwood Fawcett, the new President of Battelle, these were difficult years—a time when the future of the Institute was at stake. Yet, as the Institute entered into a time of more stability in 1975, he spoke with hope and confidence. In his report for the year 1975, Dr. Fawcett acknowledged some of the problems confronting the Institute for the years just ahead, but he went on to say: "One of the achievements of 1975 was the adoption of bold and ambitious strategic plans for Battelle. We have every confidence these plans will be fulfilled, and that the Institute will continue and, in the long run, will grow in size and significance. That was the wish of our founder, and that is the determined intent of all of us who bear responsibility for Battelle's future."

The ensuing years have brought considerable evidence that the Institute is still a growing organization even though not all of Battelle's activities have been consistently on the upswing. Battelle's ability to change with the times augurs well for the future, and overall, the picture in recent years has been encouraging. For example, total sponsored research revenues, which were $173.1 million in 1975 approached $300 million in 1978. And the staff total had climbed from 5,990 at the end of 1975 to about 6,900 at the end of 1978.

By foresight and planning, the Institute had placed itself in an excellent position to undertake a much-expanded research effort in those areas where demand was building—for example, in energy and environmental work and in the life sciences.

Breaking ground for Battelle's nuclear research center near West Jefferson, Ohio, in January of 1955. Among the onlookers as Clyde Williams wields a shovel are two of his successors—Dr.'s B. D. Thomas and Sherwood Fawcett.

The cafeteria in the original building—scene of a special luncheon in the 1950's to get members of the staff better acquainted.



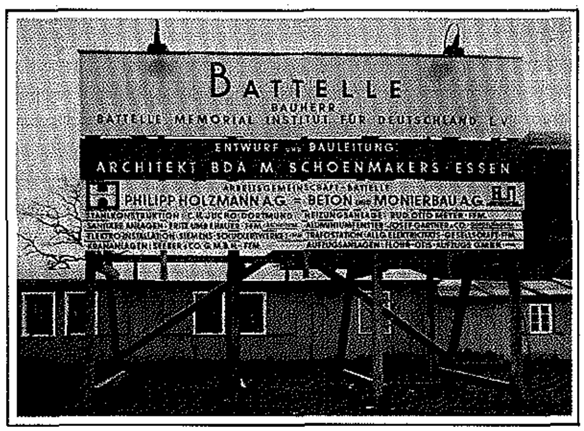
At the same time, the Institute's two subsidiaries for putting technology to work—the Battelle Development Corporation and Scientific Advances, Inc. (SAI)—have launched new efforts to capitalize on the intellectual property of Battelle. No one in the Battelle management has been so optimistic as to predict "another Xerox". There is, however, a prevailing belief that the Institute, over the years, can by adroit management bring some truly innovative products and processes to the market, thus accomplishing the purposes of Battelle, and at the same time, improving its financial position.

One recent development providing a basis for this optimism was the success of the Unirad Corporation. Unirad, nurtured from infancy by SAI, established a strong and pioneering position in the manufacture of ultrasonic medical equipment—equipment that has markedly advanced certain diagnostic procedures. Unirad was both a technical and financial success when sold by SAI in 1976.

Similarly, Nortec Corporation—a subsidiary of SAI—is one of the most successful companies in the field of nondestructive testing. Meanwhile, SAI is exploring new ways of assisting new or existing technically-based companies.

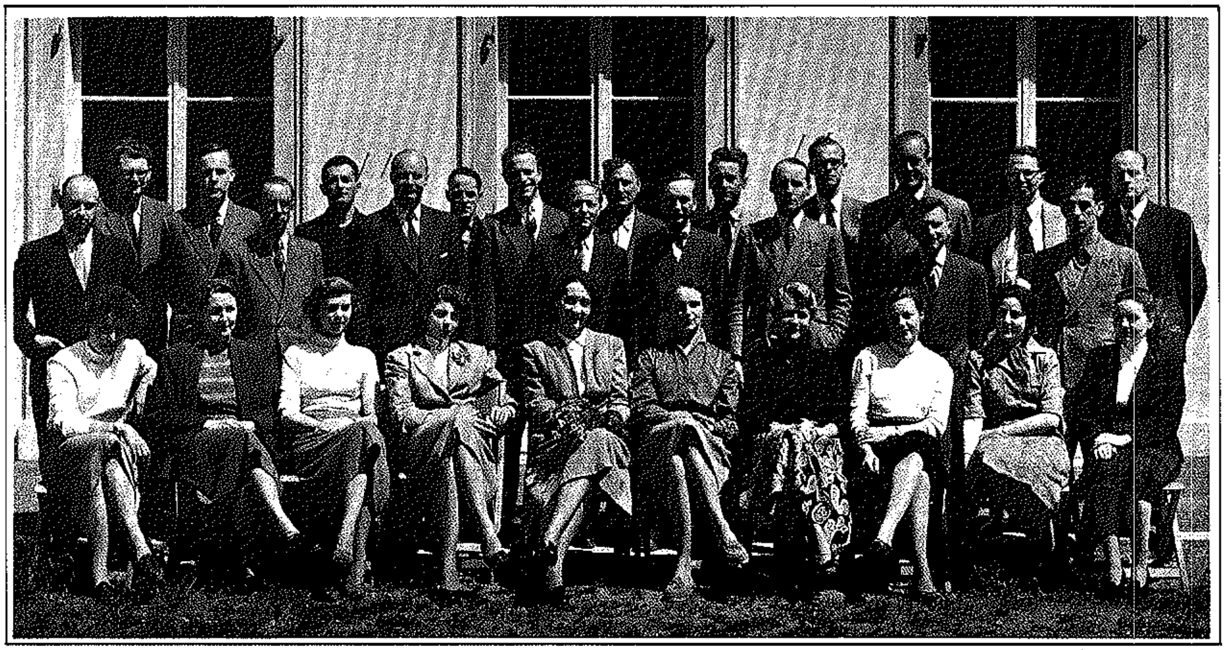
Also, the authorization in the spring of 1978 by the U.S. Department of Energy (DOE) for Battelle to manage a major program on commercial nuclear waste isolation, and the Institute's creation of a new operating division for this and other subsequent development programs were indicative of its intent to formalize and expand efforts in the management of large development-type programs. The emphasis in these programs, is on demonstration of new technology, as opposed to the research and development that precedes demonstration. In announcing the Battelle-established Office of Nuclear Waste Isolation for DOE and its placement within the newly created Project Management Division, Dr. Fawcett observed that these activities "can extend the fulfillment of Battelle's public purposes and complement its existing strengths in research and development".

But the most reassuring evidence of the Institute's worth and usefulness, and the strongest promise of its future, is the continuing line of research achievements. Development of the world's largest operating solar-powered irrigation pump. A new simplified underwater arc welding process. Improved food products. A simple hand water pump for use in developing nations. A novel fluidized-bed coal combustion process for industrial boilers. Development of the slim-hole drilling method to aid in the search for promising geothermal resources. Creation of innovative educational management and instructional systems. A new technique for cell collection that represents a marked improvement over current smear techniques. Development of ceramic materials to replace bone tissue and of implantable tooth roots. Development of the melt-extraction process for manufacturing wire-like products that enhance the properties of refractories and alloys. A prototype ultrasonic imaging system to visualize weld flaws



Sign announcing the construction of the Battelle Laboratories in Frankfurt, Germany—fall, 1952.

The Frankfurt staff grouped at the main entrance for a ceremony marking the opening of the new laboratories in 1953.



more effectively. Special new concretes to be used as a construction material for seawater desalination plants operating at high temperatures. Development of concepts for low-cost basic homes for low-income rural families. Programs aimed at improved railroad track performance. Development of an ultramicro analytical system used throughout the world to analyze blood. A variety of studies aimed at improving the environment.

An early photo of the staff at Battelle-Geneva—May, 1954.

Ceremony on January 4, 1965, marking transfer of operations of the Hanford Laboratories—renamed Battelle's Pacific Northwest Laboratories—from the General Electric Company to Battelle.

The list goes on and on—new scientific knowledge and new and practical uses of such knowledge resulting from literally thousands of research studies in progress each year.

During the first 50 years of Battelle's history, the place of science in human affairs has grown dramatically. It is unlikely that Gordon Battelle, for all of his belief in the usefulness of science, could have imagined its present importance. By the same token, it is unlikely that he could have imagined how the Institute he founded would grow, but he could not help but be extremely pleased. And he would have no difficulty recognizing the Institute as the embodiment of his idea.

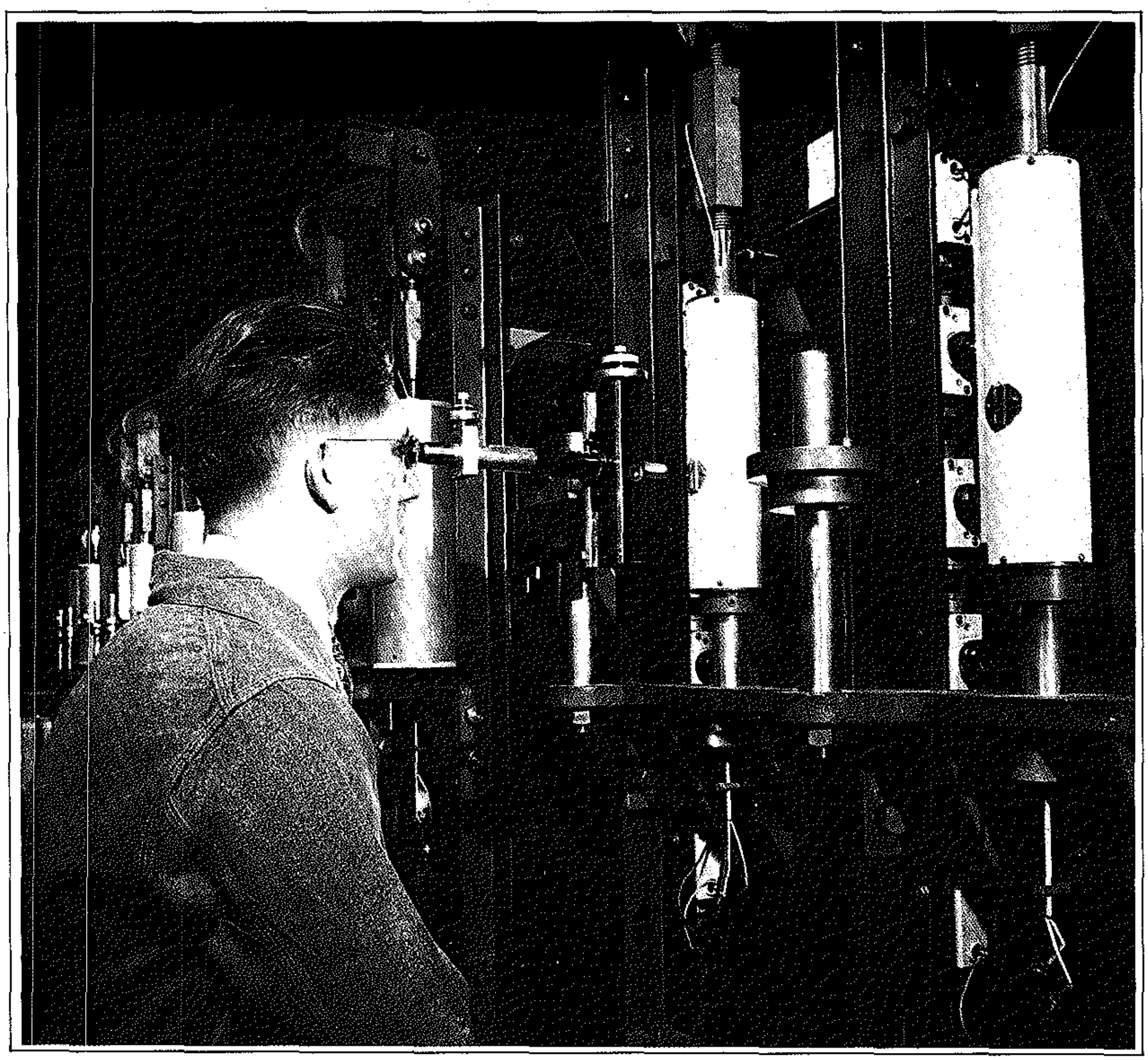
As Sherwood Fawcett has observed, "Battelle is a large organization with many facets and with a wide range of interests and activities. Its purpose, however, is simple and constant—the use of science, technology and education to meet human needs. We hope, and we believe, that this purpose shows clearly in all that we, as an organization, do and aspire to do, for it is to this central idea that we are dedicated."

Research Highlights

In recent years, Battelle has annually conducted some 3,000 studies for companies, government agencies, and associations based in literally dozens of countries. Thus, space does not permit anything like a complete listing of the thousands and thousands of studies carried out by the Institute during its first 50 years. On the other hand, no history of the Institute would be complete without some attention to Battelle's research achievements. What follows are selected examples of this research that, hopefully, give some indication of the diversity and, more importantly, the value of the Institute's work.

1978 Battelle assumed responsibility for management of a large portion of the U.S. Department of Energy's national program for the long-term storage and ultimate isolation of commercial nuclear waste through operation of the newly established Office of Nuclear Waste Isolation (ONWI). The major objectives of ONWI are to explore

Battelle's original facility for its pioneering research on creep in material.



geologic formations in the continental United States as potential sites for the storage and isolation of commercial nuclear waste and to develop the technology to support the design, construction, and preoperational testing of a repository at one of these sites.

1977 Development was well under way on Battelle energy technology that permits the burning of coal with increased efficiency and a reduction in by-product pollutants. In this novel fluidized-bed combustion process, crushed high-sulfur coal is burned with powdered limestone in a turbulent bed of air and inert solid granules that makes the combustion clean and efficient. The process is believed to be applicable to new industrial boilers, new utility boilers, and to retrofitting existing coal- and oil-fired boilers.

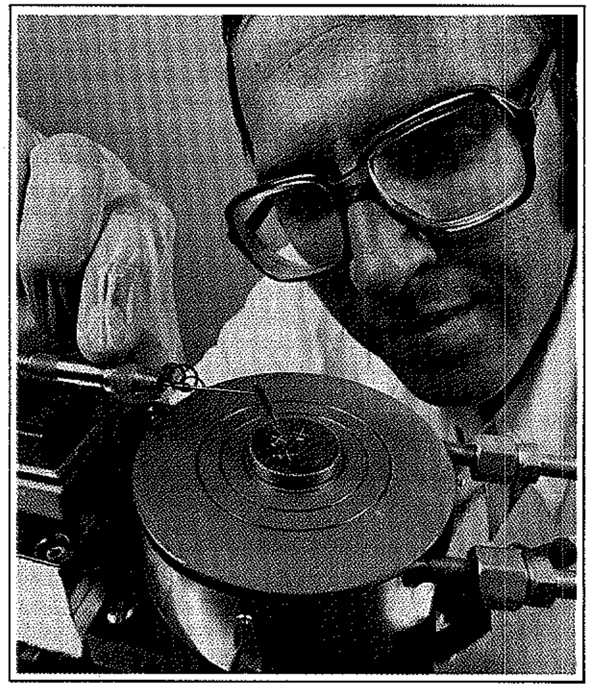
1976 Melt extraction, a process developed by Battelle for manufacturing wire-like products directly from molten metal, made its appearance in the marketplace. Tonnage quantities of stainless steel for use in Wirand® (wire-reinforced) concrete and castable refractories are being manufactured and sold.

1975 Battelle researchers completed a two-year-long look inside nuclear reactors in a $1 million study of fuel densification for a consortium of private sponsors. Results of the study have become the industry standard for producing stable nuclear fuels. It related in-reactor densification of sintered uranium oxide fuel pellets with the pellet characteristics and irradiation conditions.

1974 The first all-sputtered photovoltaic solar cell was developed to reduce the cost of electric power through direct conversion of solar energy. The sputtering deposition technique bypasses some of the problems encountered when solar cells are made by growing large silicon crystals and cutting them into wafer-thin slices—a technique in which more than half of the original crystal is lost.

1973 To meet the need for a laser that can be carried in communication satellites, Battelle developed a small but powerful sealed-off carbon dioxide laser with stabilized radiation intensity and frequency.

®Trademark of Battelle Development Corporation.



Thin-film photovoltaic solar cells fabricated by sputter-deposition in an attempt to achieve high solar conversion efficiencies in low-cost structures.

1972 A technique, which provides a protection against clotting without adding anticoagulants to the patient's blood, has proven particularly useful in surgical procedures to repair aortic aneurysms. Biomedical researchers developed this technique for binding the anticoagulant heparin to the surface of plastic materials which come into contact with the blood.

1971 Research and development by a team of biologists and materials scientists resulted in a porous substance called Void Metal Composite (VMC). Because of its ability to develop a "living union" between bone and prosthetic devices by bone ingrowth, VMC can anchor artificial teeth or femoral head prostheses or can be a surgically implanted splint for badly broken bones.

1970 Scientists succeeded in the hydrostatic extrusion-drawing of fine, defect-free beryllium wire at a rate of 2000 feet per minute, using the Battelle-developed HYDRAW process. Before this development, it was difficult to draw beryllium wire because of breakage and of the need for many in-process reduction and annealing stages.

1969 Battelle and University of Washington medical school researchers cooperated in development of in-vivo neutron activation analysis. This development enables medical researchers to determine accurately the quantity and ratios of elements in the human body.

1968 Researchers developed a technique that makes it possible to detect the sound of potential failure in newly welded seams. With acoustic weld monitoring, quality control engineers can detect acoustic emissions from defective welds for more than 20 minutes as the weld cools.

1967 Battelle developed a new electric underwater hand tool for use by divers in salvage and undersea construction operations. Capabilities of the tool include drilling, tapping, grinding, brushing, cutting, hole sawing, and bolt tightening.

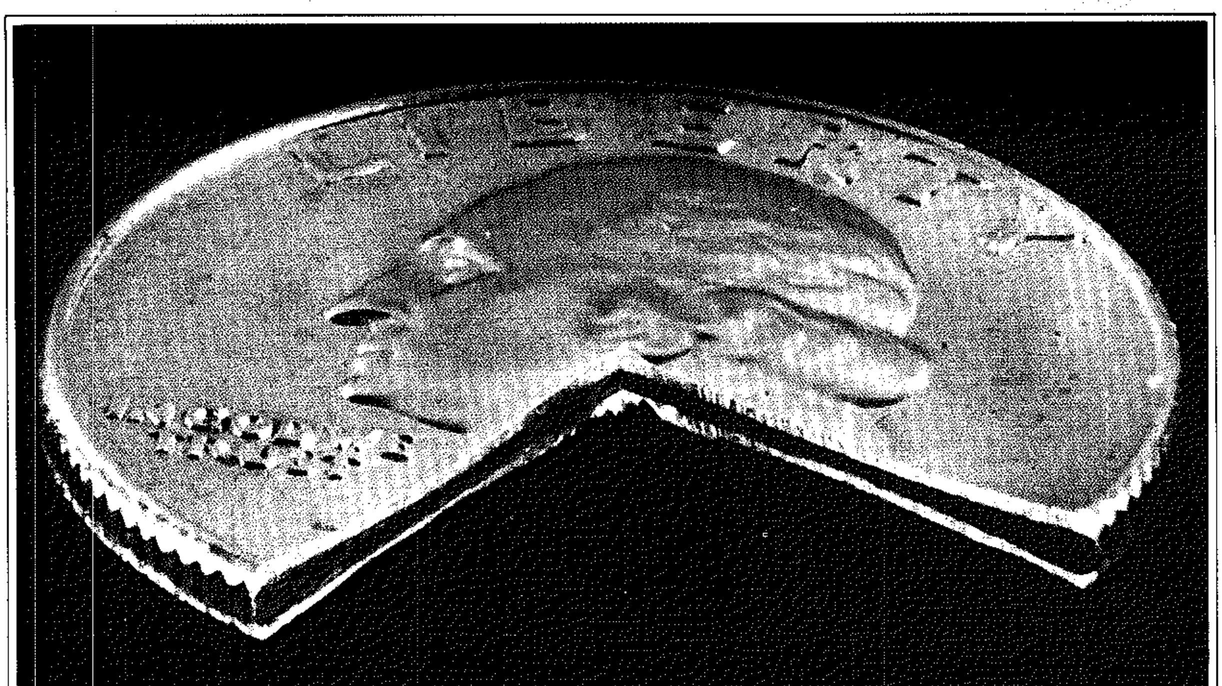
1966 The optimum suspension properties of special-purpose vehicles were theoretically determined and examined in scale-model experiments on a belt track and on the road. The results were used in designing the suspension system of a heavy motor vehicle.

1965 Much of the study leading to the U.S. Treasury Department's recommendation for coins with a copper core and a copper-nickel alloy cladding was conducted by Battelle. The composite material recommended by the Institute is being used in the coins minted by the United States.

1964 For a clothing manufacturer, researchers developed a largely automatic process for the production of shoulder pads for jackets. The assembly, which involved complicated cutting and sewing of eight different parts, previously required two minutes per pair, compared to 18 seconds for the automated process.

1963 Research was under way on a process to produce sour cream and buttermilk in a matter of minutes rather than hours. Known as the "Stabilized Acid Process", it eliminates the need for bacteria previously essential to the production of dairy foods.

A study by Institute scientists leading to the U.S. Treasury Department's recommendation for coins with a copper core and a copper-nickel alloy cladding.



1962 A new process for fabricating the consumable electrodes used in vacuum-arc melting tungsten was developed. This process provided for increased productivity of tungsten.

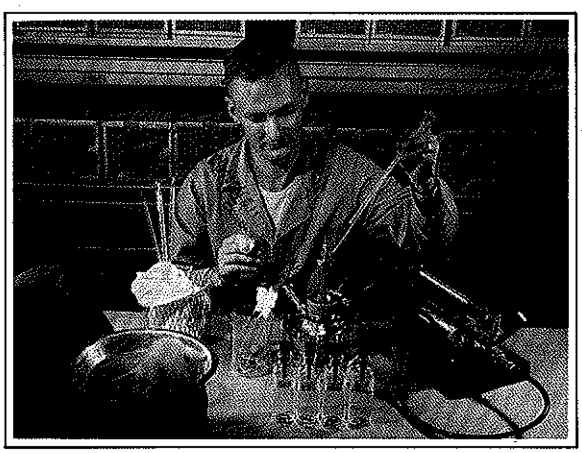
1961 A method of producing cheaper corrugated-core metal sandwich panels was developed. The process, called roll-welding, uses hot rolling to pressure-weld the peaks of the corrugated metal core to the cover sheets.

1960 Commercial production of Alumoweld® was begun by Copperweld Steel Company. Alumoweld® is steel wire heavily coated with aluminum and combines the high strength of steel with the high electrical conductivity and corrosion resistance of aluminum. The process for producing Alumoweld® was invented and developed by Battelle technologists.

1959 The development of a large printing press for improved printing of corrugated board signaled a significant advance in the corrugated-board industry. With this revolutionary new equipment, it is possible to obtain multicolor effects on corrugated board with a single impression.

1958 Battelle began its participation in the cancer chemotherapy research program of the National Institutes of Health. In addition to evaluating chemicals of possible value in treating cancer, this research involves tissue culture and a controlled breeding program for laboratory animals.

Ultrasonic treatment of virus—one phase of early work that was to form the basis for later cancer research.



1957 Battelle technologists used scale models, with air as the flowing medium, in establishing the design of water-cooled nuclear reactors to insure uniform flow and to avoid destructive, excessive temperatures.

1956 A unique method for the upgrading of rock salt was developed which makes use of the diathermic properties of rock salt and the thermoplastic properties of a resin to remove impurities. This development permits the economic exploitation of salt deposits previously considered too impure for most uses.

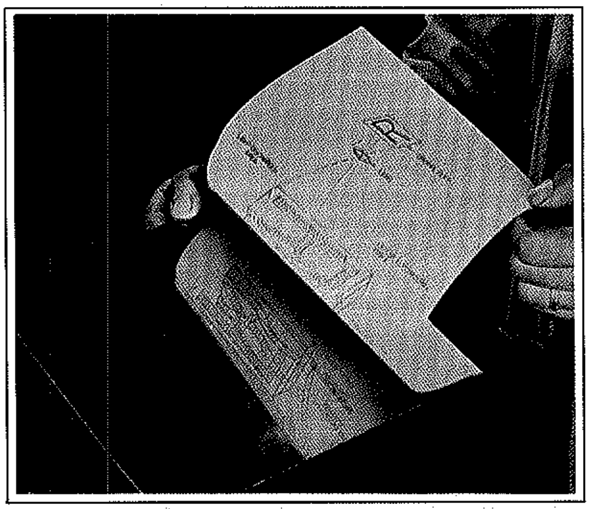
1955 At the Industry Institute of Lebanon, Battelle assisted the Lebanese in planning and establishing a research laboratory to serve the Middle East. For almost four years Battelle specialists helped train personnel and establish operating procedures for the new research center constructed during this period.

1954 Ceramists developed oxide powders with high reactivity in solid-state sintering reactions. The improved ceramics have proved valuable in nuclear fuels and moderators, electronic devices, and other refractory applications.

1953 Studies were undertaken to determine the role of anodes in the electroplating process and learn how they contribute to the production of smooth, pore-free metallic coatings. Battelle research on copper anodes was the first of its kind and is broadly recognized as the basis for improved copper plating.

1952 An intensive research effort was begun on electrolytic cutting and shaping of metal. This work has resulted in a unique cutting and shaping "tool" for the metal fabricating industry. Conventional shaping, cutting, drilling, and grinding are eliminated by using this electrolytic method that removes metals rapidly and produces a finished part.

1951 Battelle pioneered the establishment and operation of technical information centers in a variety of important areas of research. These centers—constantly innovating information-handling techniques—have helped to cope with the growing flood of technical information which makes it difficult for scientists and engineers to



Early laboratory experiments leading to the commercialization of xerography.

maintain an awareness of the "state of the art" in any given field.

1950 Use of lead telluride and its alloys in the preparation of thermoelectric power-generating devices of practical value ushered in an era of research contributions in the thermoelectric field.

1949 Pioneering studies were begun on gas transmission line technology involving design, welding, and materials. This research, over the years, has addressed fracture, welding, corrosion, vibration, and stress problems, and has contributed to the safe and efficient operation of gas transmission pipelines throughout the world and continues to do so.

1948 Research was begun on naval reactor propulsion. This research led to the development of the process by which the reactor core was made for the submarine Nautilus and its prototype.

1947 Titanium was first melted in an electric-arc furnace having a water-cooled copper crucible. Work was begun on the development of titanium-aluminum alloys. This research led to the development of titanium-base alloys used in aeronautical construction.

1946 Fundamental research on flame oscillation and high-energy combustion was undertaken. This research subsequently had an important bearing on rocket research.

1945 Research was begun on ceramic materials for rockets, missiles, gas-turbine engines, and gas-cooled nuclear reactors. Battelle ceramists have investigated a number of materials for such applications as rocket nozzles, re-entry nose cones, and reactor fuel elements.

1944 Research was begun on a photographic process using static electricity, which was later to be known as xerography. The development of this fast, dry method for reproducing drawings, print, and other line copy led, within five years, to the first commercial xerography equipment for office copy work.

1943 Battelle technologists extruded the uranium used for fuel elements in the world's second nuclear reactor at Oak Ridge, Tennessee. Thus began a continually expanding program of research on nuclear reactors encompassing materials, design, and corrosion and irradiation studies.

1942 Early studies of trace amounts of copper in mixed fertilizers demonstrated the value of such additions in increasing the yield of important crops often grown on copper-deficient soils. Continuing research resulted in important contributions on plant nutrition.

1941 Work on sulfur dioxide molding compounds marked Battelle's entry into the relatively new field of plastics research. This research has expanded, keeping pace with the plastics industry. As early as 1944, Battelle chemists had worked out a method for making high-density polyethylene.

1940 A study of zirconium led to its preparation in high-purity form by the iodine method. This research touched off a long line of developments in the production of titanium and other reactive metals in pure form. Ultimately, this led to the development of alloys that have been important in the construction of nuclear reactors and advanced aircraft.

1939 Research on gases in metals was begun with a study of the effects of hydrogen in steels. Work in this area has grown continually, and much of the present knowledge on this subject can be traced to Battelle's pioneering efforts. This research has led to improved steels free from defects caused by hydrogen.

1938 Pioneering research on machinability resulted in the development of the first free-machining, lead-containing steels. This type of steel is still the standard of excellence and permits cutting rates 40 percent higher than those for conventional steels.

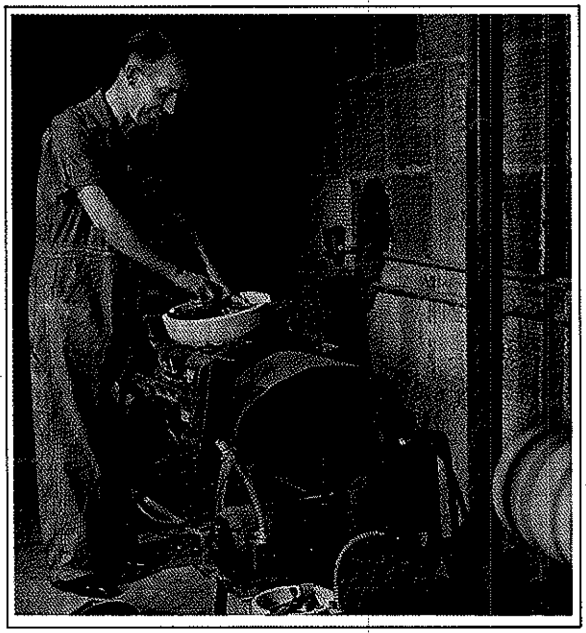
1937 Wear-resistance research resulted in the discovery that electrodeposited silver is superior to cast silver as a material for bearings. The discovery had a significant effect on bearing manufacture for aircraft during World War II.

1936 Research was begun on catalytic reactions, including reactions on ethylene and other olefins. The work has resulted, over the years, in development of automobile exhaust catalysts, a process for cracking tar in petroleum, and methods of preparing polyethylene, including the use of irradiation.

1935 Pioneering studies were undertaken on the workability of clays. One facet of this research—the effect of exchangeable bases on the properties of raw and fired clay bodies—resulted in a better understanding of problems involved in the production of ceramic ware.

1934 Early research in electrodeposition was begun with the development of a method for electrodepositing a layer of a bearing alloy on steel for use in internal combustion engines. Thus began an expanding program of research that encompasses electrowinning, electrorefining, electroforming, and electrocladding.

1933 Battelle metallurgists began research on an antimagnetic, rustproof alloy for watch springs—one of the earliest in a long series of special-purpose compositions they have developed. Later patented, the alloy was termed the most outstanding development in watch manufacture in 200 years. Apart from watches, the alloy has proved valuable in a number of unusual applications, including a mechanical valve for the human heart.



Pioneering studies on the workability of clays directed toward improved production of ceramic ware.

1932 Battelle metallurgists discovered that nickel in copper-bearing steels drastically reduces the surface cracking that normally occurs in hot-working copper-bearing steels, such as those used in construction of railroad cars and bridges.

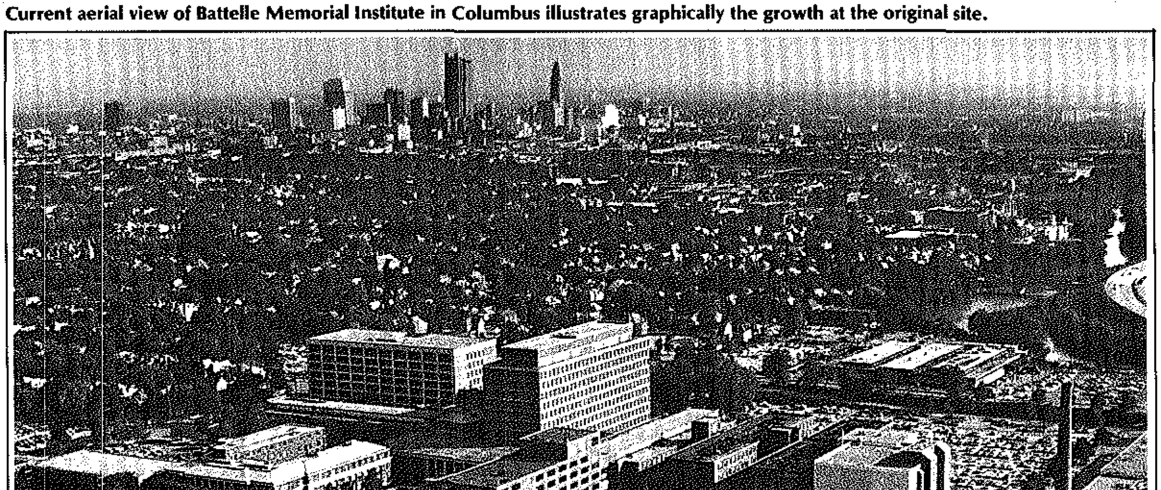
1931 An experimental determination of the mechanisms of combustion of pulverized coal provided information of basic value to the builders and users of pulverized-coal equipment. This study was the beginning of an extended program directed toward more efficient use of pulverized coal.

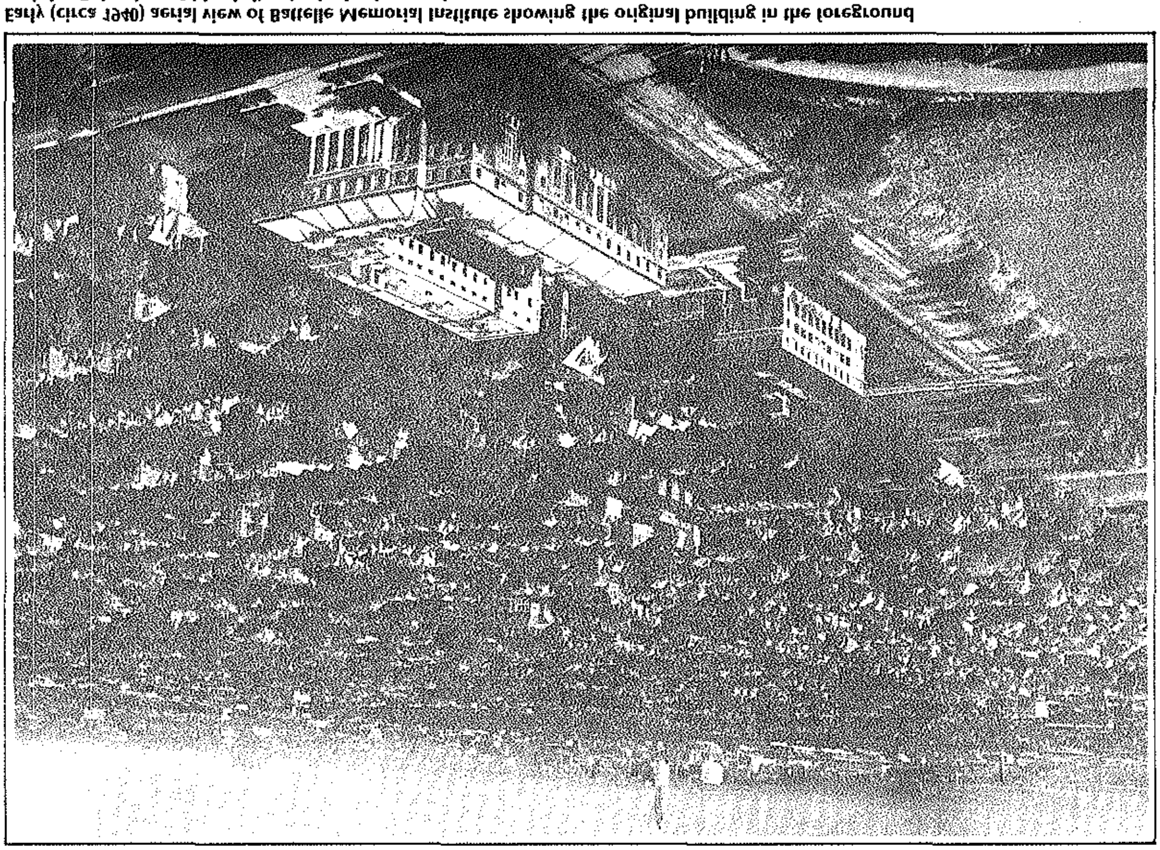
1930 Research was initiated on the creep properties of cast iron. This research has led, over the years, to further studies and fundamental understanding of the entire spectrum of materials required for use at the elevated temperatures of the space age.

1929 Battelle metallurgists prepared a number of the volumes on metallurgy that are known collectively as the Alloys of Iron Research Monograph Series. The Series has become a classic source of information on metals.

Early (circa 1940) aerial view of Battelle Memorial Institute showing the original building in the foreground and the Columbus, Ohio skyline in the background.

Current aerial view of Battelle Memorial Institute in Columbus illustrates graphically the growth at the original site.





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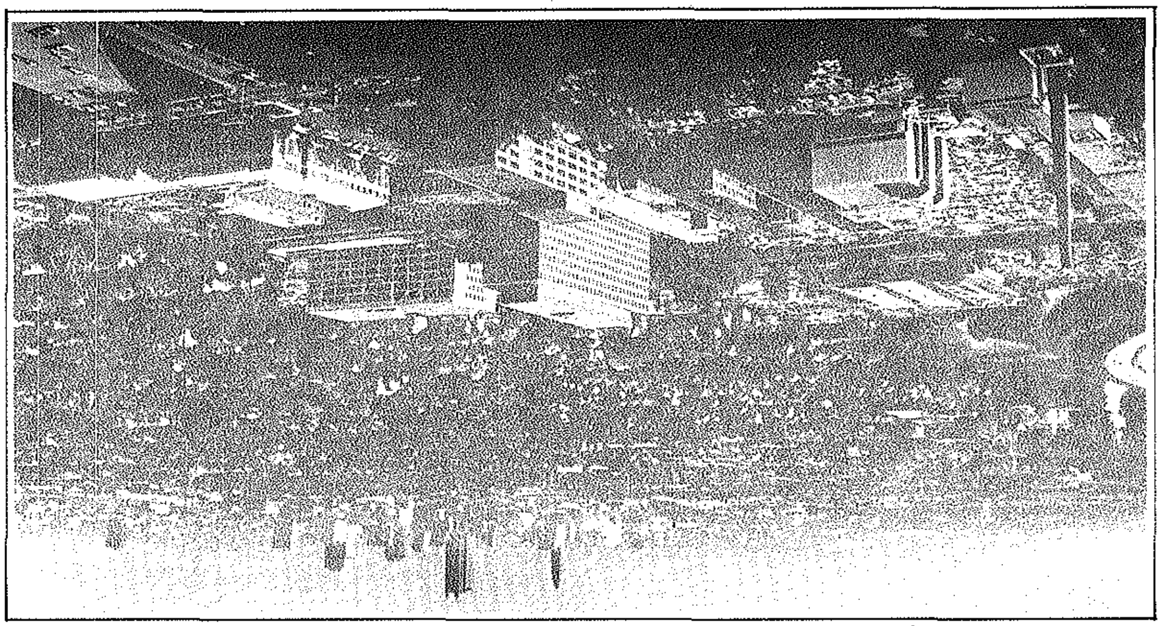

Design by Design Communications

Printing by Printing Service Company

Battelle
Office of Corporate Communications
505 King Avenue
Columbus, Ohio 43201

Printed in U.S.A.